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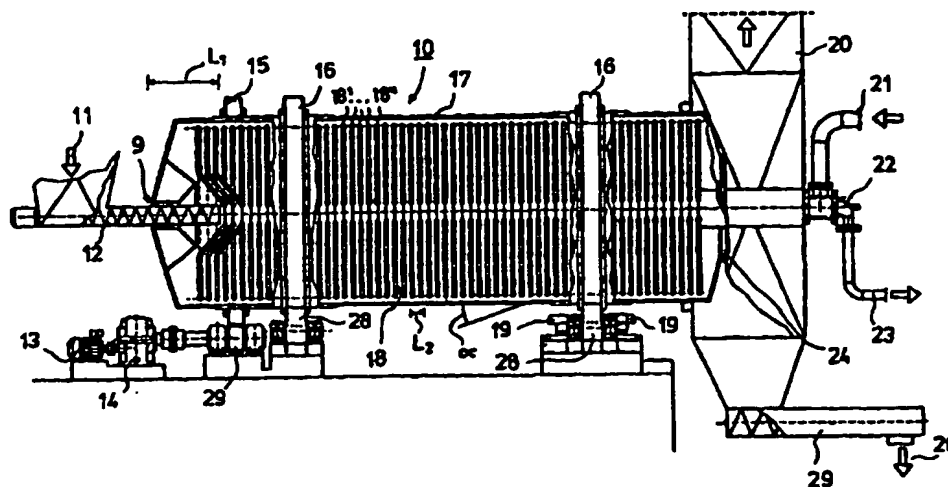
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(54) Title: STEAM DRYER



(57) Abstract

The invention relates to a steam dryer, in particular for drying concentrates, which dryer comprises a drum (17), inside which a steam distributor pipe (27) and a steam tube system (18) are centrally placed, which steam tube system is formed of a plurality of steam tube groups (18¹-18ⁿ) arranged around the steam distributor pipe (27) in a direction transverse to the length of the drum (17). The steam tube groups are situated in the direction of the length of the drum (17) at a distance (L₂) from one another substantially over the entire length of the drum (17), and the steam tubes extend in them transversely to the radius of the drum (17) and in the radial direction of the drum concentrically at a distance from one another. The drum (17) of the steam dryer (10) is arranged to rotate by means of actuators (13, 14, 29, 15) and on support of support means (28, 16) during drying together with the steam tube system (18) situated inside said drum (17) and formed of a plurality of steam tube groups (18¹-18ⁿ).

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## Steam dryer

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The invention relates to a steam dryer, in particular for drying concentrates, which dryer comprises a drum with a steam tube system placed inside it, said steam tube system being formed of a plurality of concentric tube ring groups placed, in a radial direction of the drum transversely to the drum, around a steam distributor pipe at a distance from one another substantially over the entire length of the drum, and which  
10 steam dryer comprises feed members for the material to be dried and discharge members for the dried material, and steam supply ducts as well as condensate and gas discharge means, in which steam dryer steam is arranged to be passed into the steam tube system through the steam distributor pipe situated on the central axis  
15 inside the steam dryer.

Dryer drums based on the use of steam are known from prior art, which dryers are used, among other things, for drying different concentrates. In steam dryers of this type the material to be dried is placed inside a drum or equivalent and the drying  
20 steam passes in the tubes placed inside the drum. Thus, the material to be dried does not get into direct contact with steam.

Drum steam dryers are known from prior art having steam tubes, as a rule, placed in a direction parallel to the axis of the drum. In some of these applications, an  
25 insulating material layer of the material to be dried formed on the surface of steam tubes has proved to be problematic. In the dryers known from prior art in which longitudinal tubes are used the degree of fullness of the apparatus is relatively low, about 10-15 % of the material to be dried of the inside volume of the drum, and they are not commonly used for drying concentrates because of their large size and  
30 low efficiency.

Arrangements are also known from prior art comprising a separate rotor which constitutes a heating surface and around which there is a fixed basin that is stationary in a horizontal plane. The rotor consists of a plurality of parallel tube groups arranged along a central tube. Each tube group comprises a number of concentric tube rings, and the heat transfer medium used may be steam or a liquid. In this prior art arrangement, the steam tube system situated inside the steam dryer, carried in bearings at ends and rotating in the concentrate to be dried imposes a restriction on size and it cannot be economically increased with an increase in the amount of concentrate. In addition, in this arrangement the wear of steam tubes causes great problems when drying abrasive concentrates.

An object of the invention is to provide a steam dryer which is suitable for drying concentrates in particular and in which it is possible to utilize the steam produced elsewhere in the treatment process of concentrates.

Further, an object of the invention is to provide an arrangement in which wear has been eliminated or at least minimized and in which an insulating concentrate layer cannot form on the surface of steam tubes.

Further, an object of the arrangement in accordance with the invention is to provide an apparatus structure whose size is not restricted but can be made according to a desired concentrate amount.

With a view to achieving the objectives stated above and those that will come out later, the steam dryer according to the invention is mainly characterized in that the drum of the steam dryer and said steam tube system situated inside it and formed of a plurality of concentric tube ring groups are arranged to rotate together during drying by means of actuators on support of support means.

In the arrangement in accordance with the invention the steam tube system rotates with the drum, and longitudinal lifting blades situated on the inner face of the drum eliminate excessive sliding of the material on the face of the drum, so that neither

the wear of steam tubes nor the accumulation of material on the face of steam tubes cause problems, and the size of the structure is not restricted as a result of a bearing arrangement of the steam tubes or another equivalent factor.

5 In the dryer in accordance with the invention, the material to be dried is fed into the drum by means of a screw conveyor to a certain distance from an end, which facilitates drying and prevents the formation of lumps. Before starting the drying, a dry and hot initial drying material is produced inside the dryer, the wet goods to be dried being mixed with it when being fed into the dryer, so that the risk of the  
10 formation of lumps is further reduced. The dryer is provided with an overflow edge, over which the material discharges and which overflow edge at the same time ensures a sufficient delay of the material in the dryer and simultaneously a sufficient degree of fullness. In addition, the drum can be rotated in both directions in order to equalize possible wear.

15 The arrangement in accordance with the invention provides high drying efficiency because the degree of fullness can be selected so as to be as high as possible and the drum is full of steam tubes. In the dryer of the invention it is possible to use a degree of fullness of over 30 % of the material to be dried of the inside volume of  
20 the drum.

The drum of the steam dryer in accordance with the invention may also be in an inclined position, either downwards or upwards, to make the movement of goods more effective or to increase the delay thereof in the dryer.

25 In the following, the invention is described in more detail with reference to the figures of the accompanying drawing, to the details of which the invention is, however, in no way intended to be narrowly confined.

30 Fig. 1 schematically shows a longitudinal cross section of a steam dryer.

Fig. 2 schematically shows a section of the steam dryer in a cross direction.

Fig. 3 shows another embodiment of the steam dryer in accordance with the invention as a view corresponding to that of Fig. 2 but on a different scale.

In accordance with Figs. 1 and 2, the wet concentrate to be dried is fed into a steam  
5 dryer 10 through a feeding funnel 11 into a feed screw 12, from which it is passed  
into a drum 17 to a distance  $L_1$  from an inlet end 9 of the drum 17. The distance  $L_1$   
is 1—2 m, preferably 1.5 m. A steam tube system 18 is placed inside the drum 17,  
steam being passed into said steam tube system through a tube 21 and through a  
rotating steam connection 22. Steam is passed into the supply tube 21 preferably  
10 from a stage of the treatment process of the concentrate where steam is produced. In  
the illustration of Figs. 1 and 2, the steam tube system 18 is formed of a plurality of  
steam tube groups  $18^1—18^n$  formed of concentric steam tube rings one within the  
other, which steam tube groups are placed around a steam manifold 27 at a small  
distance  $L_2$  from one another substantially over the entire length of the drum 17.  
15 The distance  $L_2$  is 50—300 mm, preferably 80-150 mm. Each steam tube group  
 $18^1—18^n$  is connected to the steam manifold 27 by one or more connecting tubes  
31. The tubes of the steam tube system 18 situated at the end of the drum 17 on the  
side of the feed screw 12 are preferably bent in a direction away from the end,  
thereby enabling the feed screw 12 to extend to a desired distance  $L_1$  inside the  
20 drum 17 from the inlet end 9.

The condensate produced from steam during drying is passed away along a conden-  
sate tube 23 and the exhaust gases of drying are passed along a gas duct 20 to a  
filter. The drum 17 and the tube system 18 rotate on support of carrier rollers 28 by  
25 means of a toothed wheel 29 and a toothed rim 15. The drive power of rotation is  
provided, for instance, by means of a drive motor 13 and a gear 14. The carrier  
rims of the drum 17 are denoted with the reference numeral 16 and axial support  
rollers with the reference numeral 19. Two carrier rims 16 supported on the carrier  
rollers 28 are placed around the drum 17 at a distance from each other. When the  
30 drum 17 and the tube system 18 rotate, the material to be dried passes through the  
drum 17 and, with lifting blades 30 inhibiting the material from sliding on the inner  
face of the drum 17, it discharges over an adjustable overflow edge 24 into a

discharge screw 25, and the dried concentrate indicated by the reference arrow 26 is obtained as a result. The inclination angle  $\alpha$  of the drum can be adjusted and it may be  $+2^\circ$  —  $-5^\circ$ , preferably  $-1^\circ$  —  $-3^\circ$ . The drying delay of the concentrate in the steam dryer 10 can be regulated by means of the inclination angle  $\alpha$ , the adjustable speed of rotation and the adjustable overflow edge 24.

The illustration in Fig. 3 largely corresponds to that which has already been described above with reference to Figs. 1 and 2. The most essential difference with respect to the illustration of Fig. 2 is that in the embodiment now under consideration the steam tube groups are not formed of continuous steam tube rings of almost  $360^\circ$ , but, instead, in the arrangement of Fig. 3 each steam tube group consists of several sectors 18a—18h. Fig. 3 illustrates that the tubes situated in the sectors are formed of parts of a ring (sectors 18a—18d) or of parts of a straight tube (sectors 18e—18h). Each sector 18a—18h is connected to the steam manifold 27 by a connecting tube 31. In the illustration of Fig. 3 the number of sectors 18a—18h is eight, in which case the angle of each sector is mainly  $45^\circ$ , but the number of the sectors may differ from the foregoing. The transfer of heat from the steam tube system to the material to be dried may be considered to be more effective and more uniform in the illustration of Fig. 3 than in the arrangement of Fig. 2, because each sector is connected separately by a connecting tube to the steam manifold 27. The joint between the connecting tube 31 and the manifold 27 may be made, for instance, by welding or by some mechanical attachment.

Above, the invention has been described with reference to only one preferred embodiment thereof, to the details of which the invention is, however, in no way intended to be narrowly confined. Many modifications and variations are possible within the scope of the inventive idea defined in the following claims.

## Claims

1. A steam dryer, in particular for drying concentrates, which dryer comprises a drum (17), inside which a steam distributor pipe (27) and a steam tube system (18) are centrally placed, which steam tube system is formed of a plurality of steam tube groups (18<sup>1</sup>—18<sup>n</sup>) arranged around the steam distributor pipe (27) in a direction transverse to the length of the drum (17), which steam tube groups are situated in the direction of the length of the drum (17) at a distance (L<sub>2</sub>) from one another substantially over the entire length of the drum (17), and in which steam tube groups (18<sup>1</sup>—18<sup>n</sup>) the steam tubes extend mainly transversely to the radius of the drum (17) mainly concentrically at a distance from one another in the radial direction of the drum, and which steam dryer (10) comprises feed members (11,12) for the material to be dried and discharge members (24,25) for the dried material, and steam supply ducts (21,22) as well as condensate and gas discharge means (23,20), the steam in the steam dryer (10) being arranged to be passed into the steam tube system (18) through the steam distributor pipe (27) situated on the central axis inside the steam dryer (10), **characterized** in that the drum (17) of the steam dryer (10) is arranged to rotate by means of actuators (13,14,29,15) and on support of support means (28,16) during drying together with the steam tube system (18) situated inside said drum (17) and formed of a plurality of steam tube groups (18<sup>1</sup>—18<sup>n</sup>).
2. A steam dryer as claimed in claim 1, **characterized** in that said support means comprise carrier rims (16) and carrier rollers (28) fitted in connection with the drum (17) of the steam dryer (10) for supporting the drum (17) and the steam tube system (18) when they rotate.
3. A steam dryer as claimed in claim 1 or 2, **characterized** in that said actuators comprise a toothed rim (15) fitted on the outer face of the drum (17) and a toothed wheel (29), by means of which the drum (17) and the steam tube system (18) are arranged to be rotated by the drive power obtained from actuators (13,14).



4. A steam dryer as claimed in any one of the preceding claims, **characterized** in that the steam distributor pipe (27) is connected to a steam supply duct (21) by means of a rotating steam connection (22).
- 5 5. A steam dryer as claimed in any one of the preceding claims, **characterized** that the steam tube groups ( $18^1-18^n$ ) consist of several concentric steam tube rings one within the other, and that each steam tube group ( $18^1-18^n$ ) is connected to the steam manifold (27) by one or more connecting tube (31).
- 10 6. A steam dryer as claimed in any one of claims 1—4, **characterized** in that the steam tube groups ( $18^1-18^n$ ) consist of several parts of a steam tube ring or a straight tube situated one within the other in the radial direction of the drum (17) forming sectors (18a—18h) in the drum (17), and that each ring sector (18a—18h) is connected to the steam manifold (27) by at least one connecting tube (31).
- 15 7. A steam dryer as claimed in any one of the preceding claims, **characterized** in that the steam dryer (10) is placed in a position inclined relative to the horizontal direction, the angle ( $\alpha$ ) of inclination being  $+2^\circ - -5^\circ$ .
- 20 8. A steam dryer as claimed in any one of the preceding claims, **characterized** in that the feed members of the material to be dried comprise a feed screw (12), which is arranged to extend into the drum of the steam dryer (10) to a distance ( $L_1$ ) from the inlet end (9) of the steam dryer (10).
- 25 9. A steam dryer as claimed in any one of the preceding claims, **characterized** in that longitudinal lifting blades (30) are mounted on the inner face of the drum (17) of the steam dryer (10).
- 30 10. A steam dryer as claimed in any one of the preceding claims, **characterized** in that the members for discharging the dried material from the steam dryer (10) include an overflow edge (24) that is adjustable in position for the purpose of regulating the amount of the discharging dried material.

11. A steam dryer as claimed in any one of the preceding claims, **characterized** in that the discharge members for the dried material include a discharge screw (25).
12. A steam dryer as claimed in any one of the preceding claims, **characterized** in  
5 that the speed of rotation of the steam dryer (10) can be regulated and that the steam dryer (10) can be rotated in both directions.
13. A steam dryer as claimed in any one of the preceding claims, **characterized** in  
10 that the steam used in the steam dryer (10) is steam that is produced at another stage of the treatment process of the concentrate.
14. A steam dryer as claimed in any one of the preceding claims, **characterized** in  
15 that the tubes of the tube ring group of the steam tube system (18) situated on the side of the inlet end (9) of the drum (17) of the steam dryer (10) and on the side of the steam distributor pipe (27) are bent in a direction away from the inlet end (9) of the drum (17).

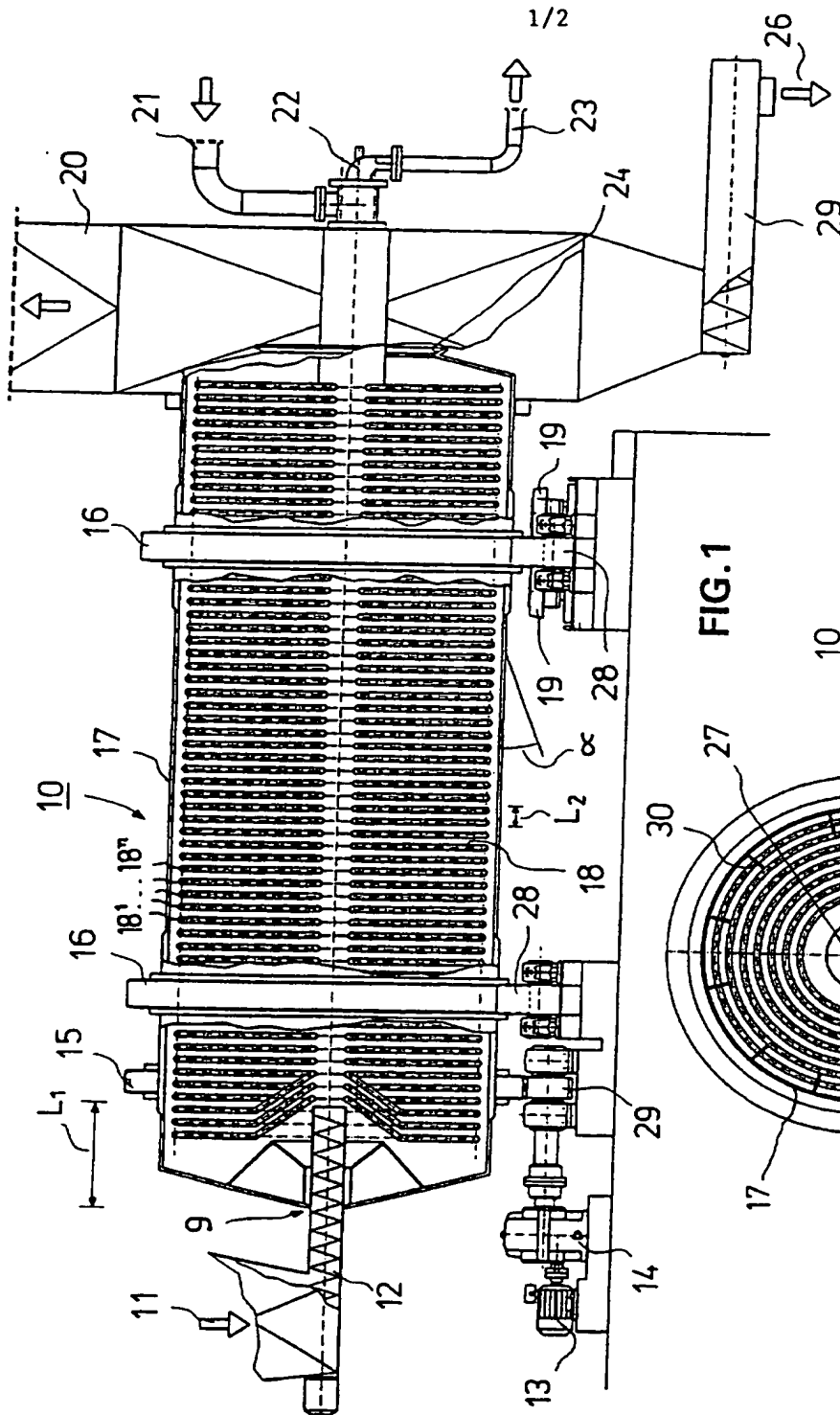


FIG. 1

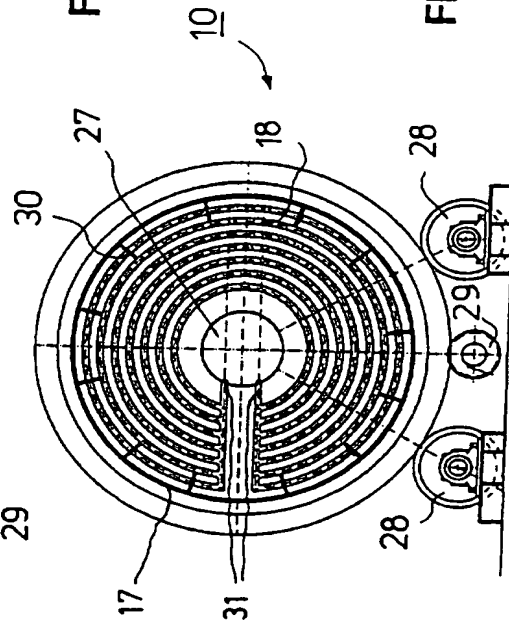


FIG. 2

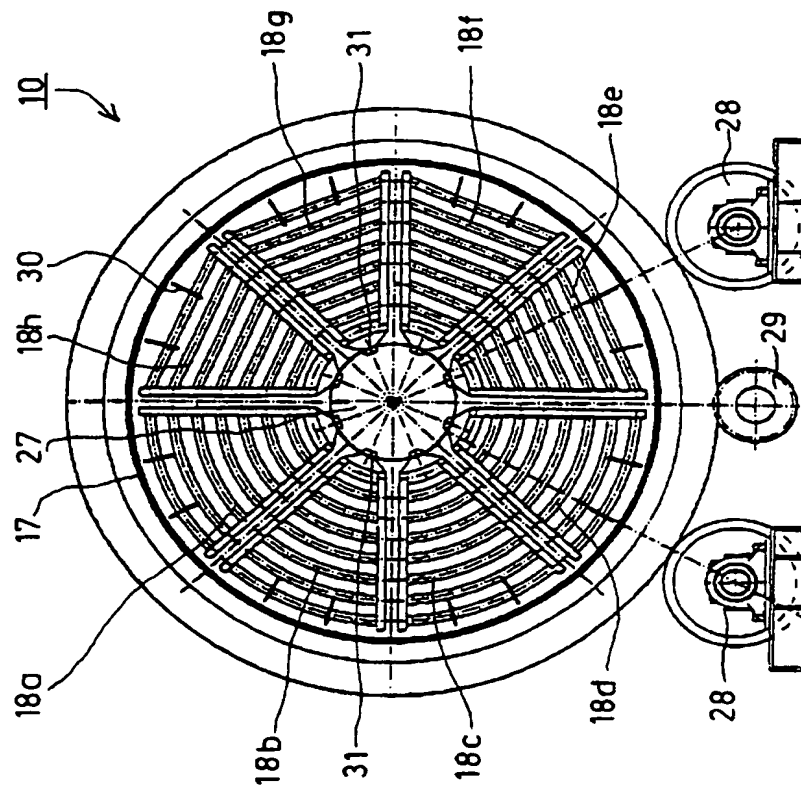


FIG. 3

1  
INTERNATIONAL SEARCH REPORT

International application No.  
PCT/FI 97/00385

**A. CLASSIFICATION OF SUBJECT MATTER**

**IPC6: F26B 17/32**  
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**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                    | Relevant to claim No. |
|-----------|---|-----------------------|
| X         | DE 2724639 B2 (MAMISTOV, VASILY VASILIEVITSCH ET AL), 23 August 1979 (23.08.79), column 3, line 7 - line 52<br><br>-- | 1-5,7-13              |
| A         | US 1510307 A (L.R. CHRISTIE), 30 Sept 1924 (30.09.24), page 1, line 41 - line 104<br><br>--<br>-----                  | 1-3,7-9               |

☐ Further documents are listed in the continuation of Box C.

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**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

01/09/97

International application No.  
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| Patent document<br>cited in search report |         |    | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|---|---------|----|---------------------|----------------------------|---------------------|
| DE  | 2724639 | B2 | 23/08/79            | NONE                       |                     |
| US  | 1510307 | A  | 30/09/24            | NONE                       |                     |